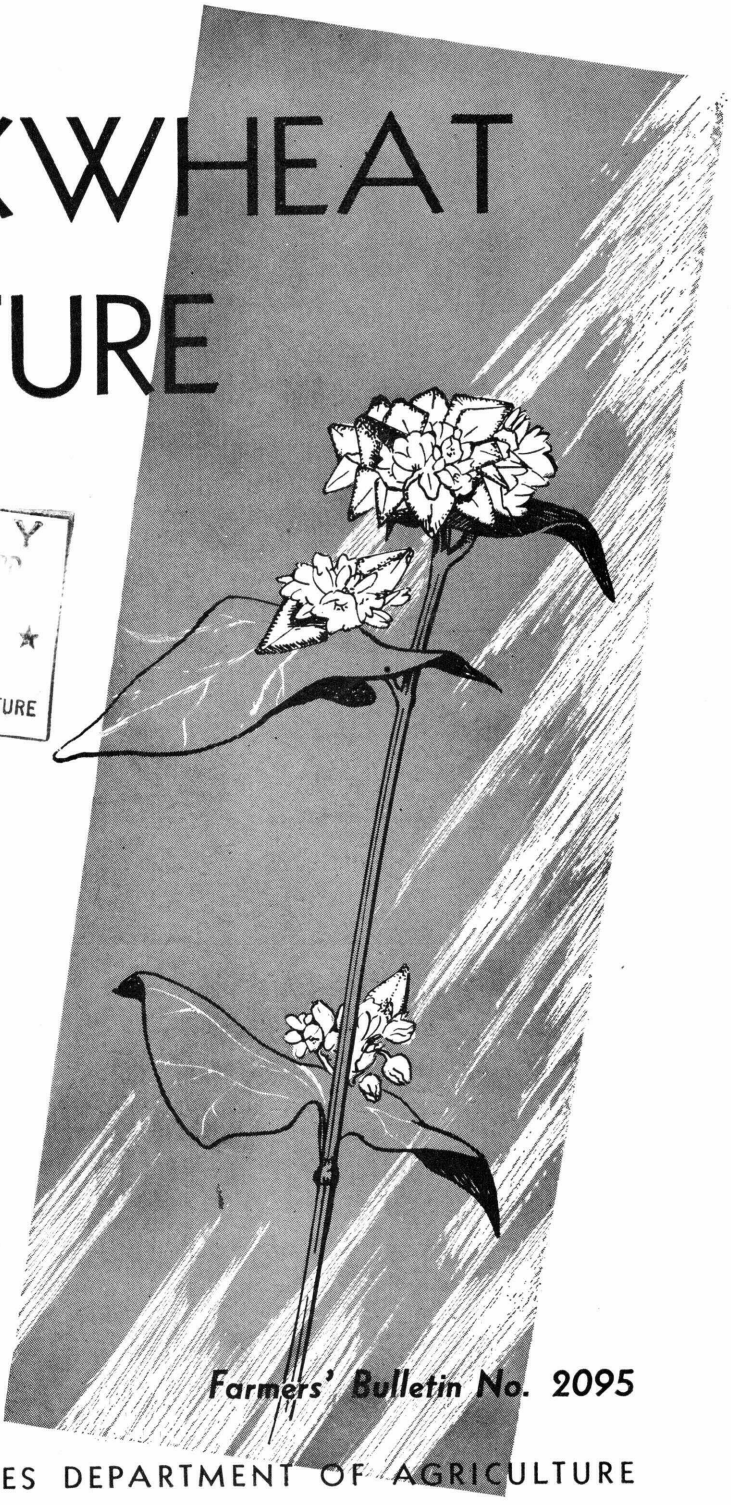
BUCKWHEAT CULTURE



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CONTENTS

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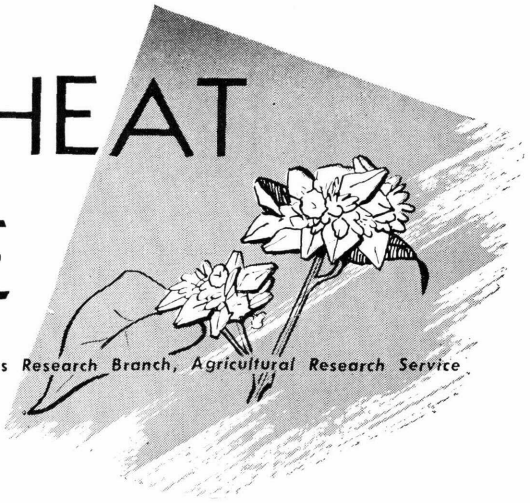

By W. J. Sando, *agronomist, Field Crops Research Branch, Agricultural Research Service*

Buckwheat[1] is a minor grain crop in the United States. It is important for two main reasons: It is considered the best crop to grow on relatively unproductive land. It matures quickly and can be grown when other crops fail or planting is delayed beyond the usual seeding date.

Buckwheat is used as a source of honey, as a smother crop to crowd out weeds, as a cover crop in orchards and vineyards, as a companion crop, and as a green manure crop.

The grain is a source of human food, and it is fed to livestock and poultry. The rutin extract from buckwheat is used for medicinal purposes.

The crop has been grown in America since colonial days. Production in the United States increased until the 1860's, then declined. The largest crop of buckwheat ever produced in the United States was about 22,000,000 bushels in 1866. In 1952 the production was about 3,163,000 bushels; it was grown on about 161,000 acres.

The reduction in buckwheat production is due to a lower consumption of starchy foods and to a declining taste for buckwheat cakes. In addition, improved farm machines permit quicker planting of other crops so that there is less need for a quick-maturing crop like buckwheat.

The principal buckwheat-producing States, listed in the order of the amounts grown, are New York, Pennsylvania, Wisconsin, Minnesota, Michigan, Ohio, and West Virginia. Figure 1 shows the distribution and acreage of buckwheat in the United States in 1949. The greatest concentration is in western New York and north-central and western Pennsylvania.

Buckwheat is also grown in Bulgaria, Canada, France, Union of Soviet Socialist Republics, and Poland, and to some extent in Austria, Denmark, Germany, Great Britain, Holland, Italy, Japan, Rumania, Union of South Africa, and Sweden.

[1] *Fagopyrum* spp.

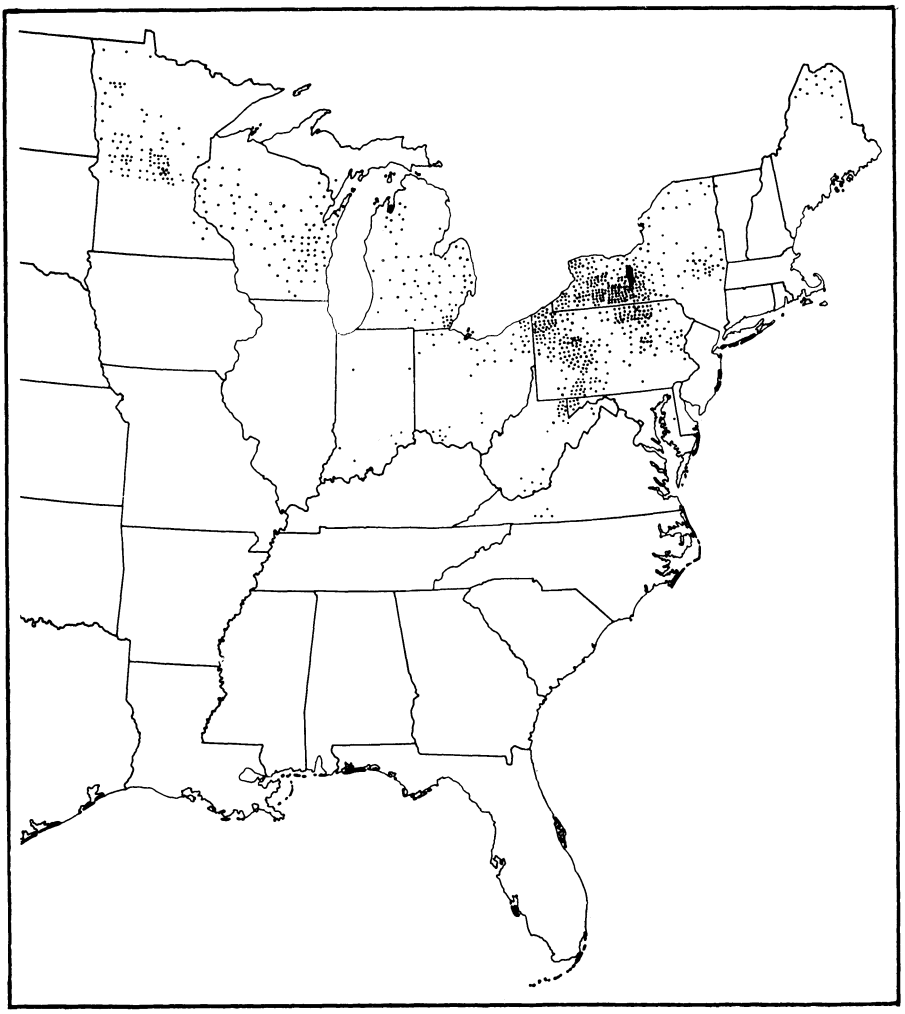

FIGURE 1.—Acreage of buckwheat in the United States in 1949. (Each dot represents 250 acres.) (U. S. Census of 1950.)

DESCRIPTION OF THE PLANT

Although it is usually considered to be a grain or cereal crop, buckwheat is not a member of the grass family and therefore not a true cereal. It belongs to the Polygonaceae, or buckwheat, family that includes such weeds as dock, sorrel, knotweed, black bindweed, and climbing false buckwheat.

The buckwheat plant is an herbaceous, erect annual, normally attaining a height of 2 to 3 feet (figs. 2, 3). Each seed produces only a single stem. Each stem bears branches that are green to purplish red when young and brown when mature. The leaves are arranged alternately on the stem. They are triangular-heart shaped or halberd shaped, are 2 to 4 inches in length and breadth, and are borne on short peti-

oles that may be nearly 4 inches long.

The flowers, which have no petals, are borne in racemes at the ends of the branches or on short pedicels that arise from the axils of the leaves (fig. 4). Each flower usually consists of a calyx composed of 5 petallike sepals that vary from white or light green to pink or red. In addition the flower contains a 1-celled ovary—3-parted style, with knoblike stigmas—and 8 stamens. Glands (usually 8) located adjacent to the ovary and near the base of the flower secrete the nectar that attracts bees and other insects. Some of the flowers of the Japanese, Silverhull, and Common Gray varieties have long stamens, others have short ones. The length of the pistils may also vary.

Common buckwheat is largely self-sterile, but insects carrying pollen from one plant to another insure cross-fertilization of the flowers and the production of seed. Intercrossing causes mixed types to appear when varieties of common buckwheat are grown close together.

The buckwheat seed consists of a pericarp, or hull, that tightly envelops the endosperm, the embryo, and two cotyledons. The shape, size, and color of buckwheat seed vary considerably. The hull of the seed may be silver gray, brown, or black. It may be mottled or light-spotted, glossy or dull. It may be smooth, or rough, with lateral furrows. The seed may have many angles (fig. 5) or only three (fig. 6). It may be winged, top shaped (turbinate), sharp pointed, or spiny (figs. 6, 7). A rare type of seed has a semidehiscent hull. The seed is $\frac{3}{16}$ to $\frac{3}{8}$ inch long and $\frac{1}{8}$ to $\frac{3}{8}$ inch wide.

The buckwheat plant has a single, stout taproot. Lateral roots that may become further branched emanate from the taproot. The root system represents an average dry weight of 3 to 4 percent of the total plant but may approach 10 percent under certain conditions.

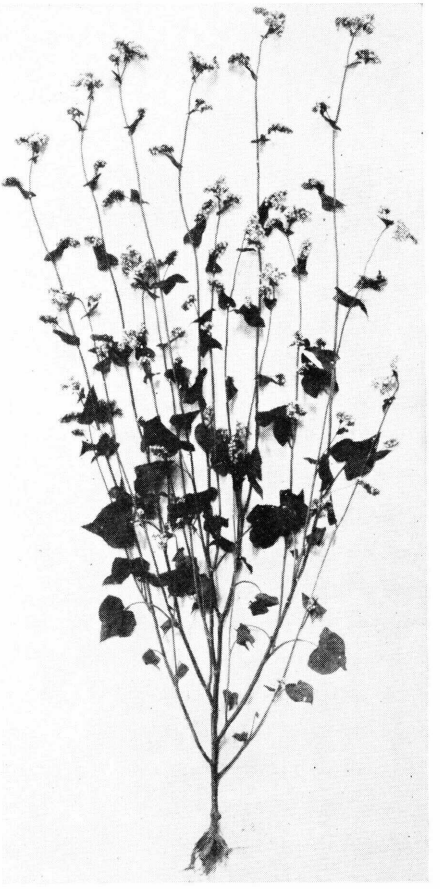

FIGURE 2.—Plant of Japanese buckwheat in bloom.

CLIMATIC REQUIREMENTS

Buckwheat grows best where the climate is moist and cool. It can be grown rather far north and at high altitudes, because its growing period is short (10 to 12 weeks) and its heat requirements for development are small.

Buckwheat is extremely sensitive to unfavorable weather conditions. It is killed quickly at freezing temperatures. Hot, drying winds, or high temperatures and dry weather at blooming time, especially when both days and nights are hot, may blast the flowers and prevent seed formation. Buck-

FIGURE 3.—Plant of Tartary buckwheat in bloom.

wheat seeding is therefore timed so that the plants will bloom and set seed when the hot, dry weather is over.

SOIL ADAPTATION

Buckwheat grows in a wider variety of soil types than any other grain crop. It produces a better crop than any other grain on infertile, poorly tilled lands if the climate is moist and cool. Buckwheat is grown only occasionally on land that is suited for the production of other grains. It is often sown on newly cleared land, on drained marshland, or on other land where decaying leaf mold or other vegetable matter makes conditions unsuitable for most other grain crops.

Buckwheat has a higher tolerance to soil acidity than any other grain crop. It is benefited by a light application of lime on extremely acid soils. It grows well where alfalfa or red clover would not succeed. Buckwheat does not grow well in heavy, wet soils or in soils that are abundant in limestone.

On light, well-drained soils, such as

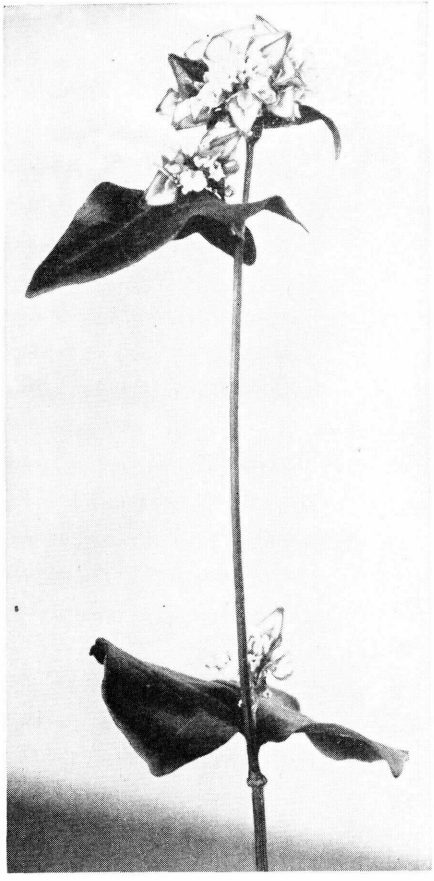

FIGURE. 4.—Branch of Japanese winged buckwheat showing flowers and seeds.

sandy loams and silt loams high in nitrogen, lodging may occur and cause a reduction in yield. Once lodged, a buckwheat plant does not return to its upright position.

On clay soils the stand can be materially reduced because the seedlings may be unable to break the hard crust or may be critically injured during emergence.

SOIL PREPARATION

Buckwheat is often sown on carelessly and hastily prepared land, or on land so rough and stony that good preparation is impossible. It frequently produces fair crops under such conditions, but better returns are possible when the seedbed is prepared carefully. Thorough preparation of the seedbed is essential for a good yield when buckwheat is sown on land where previous crops have failed.

For best results, the land should be plowed early in the spring and kept in condition by occasional harrowing until the crop is sown; the harrowing preserves the moisture that is necessary for a good crop. Good yields may also be obtained on land that is plowed, harrowed, and cultipacked just before sowing.

The seed can be sown on fields that may be poor for hay and grass, such as old meadow and pasture lands. If possible, such land should be plowed deeply several weeks before sowing time and worked occasionally with the disk or harrow to keep down weeds, conserve moisture, and improve the physical condition of the soil. Many buckwheat growers work the land in June, shortly before sowing the crop, but after silage corn or other late crops are planted. The soil preparation is the same as for spring grain crops when buckwheat is seeded early or in mixture with oats and barley.

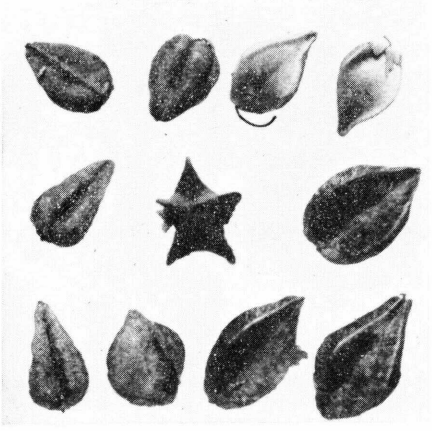

FIGURE 5.—Buckwheat seed: Four-angled seeds of Tetratataricum, Silverhull, Japanese, and (center) five-angled Japanese. (X2)

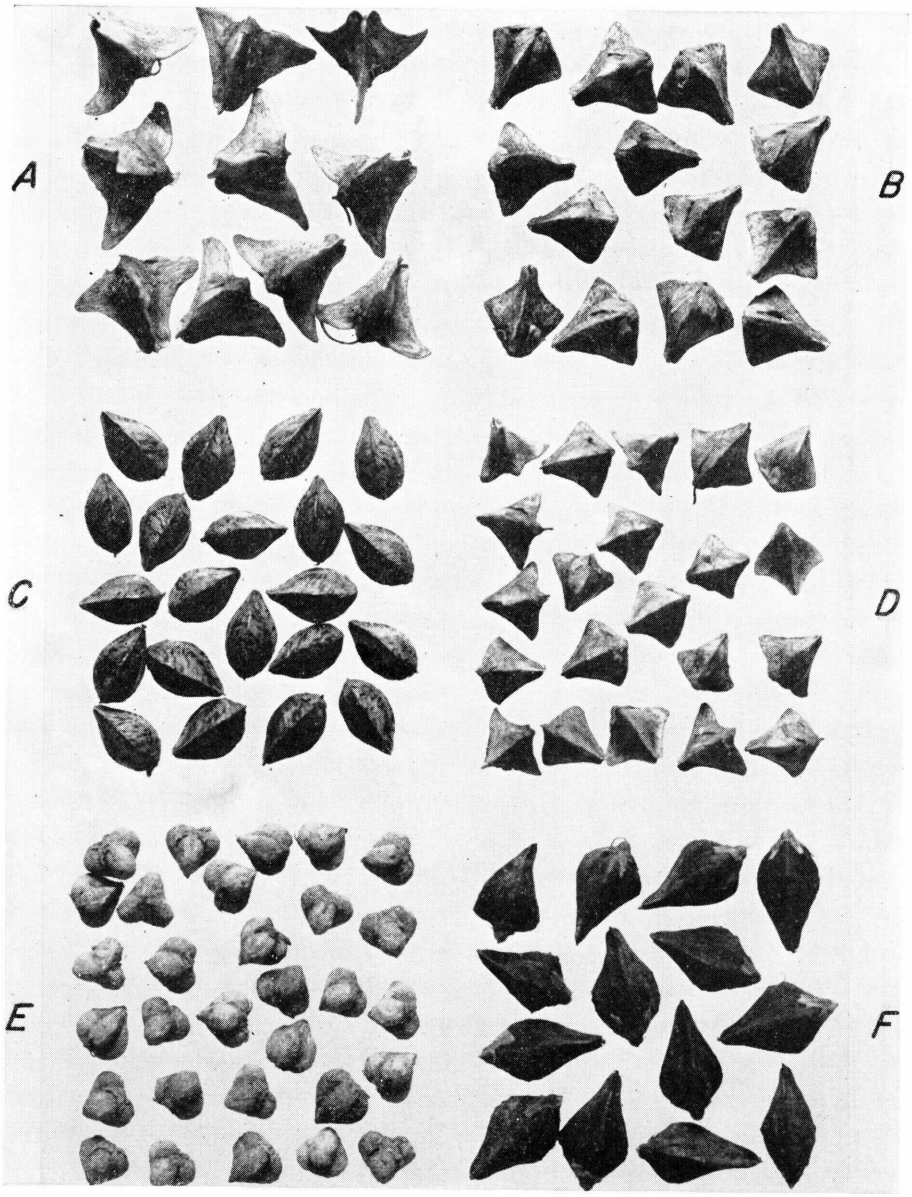

FIGURE 6.—Types of buckwheat seed: *A*, Large-winged Japanese grown in greenhouse; *B*, small-winged Japanese grown outdoors from large-winged seed; *C*, Silverhull with mottled hull; *D*, Silverhull with wings; *E*, small, smooth-hulled, top-shaped (turbinate) Tartary; *F*, sharp-pointed form of *F. esculentum*. (X2)

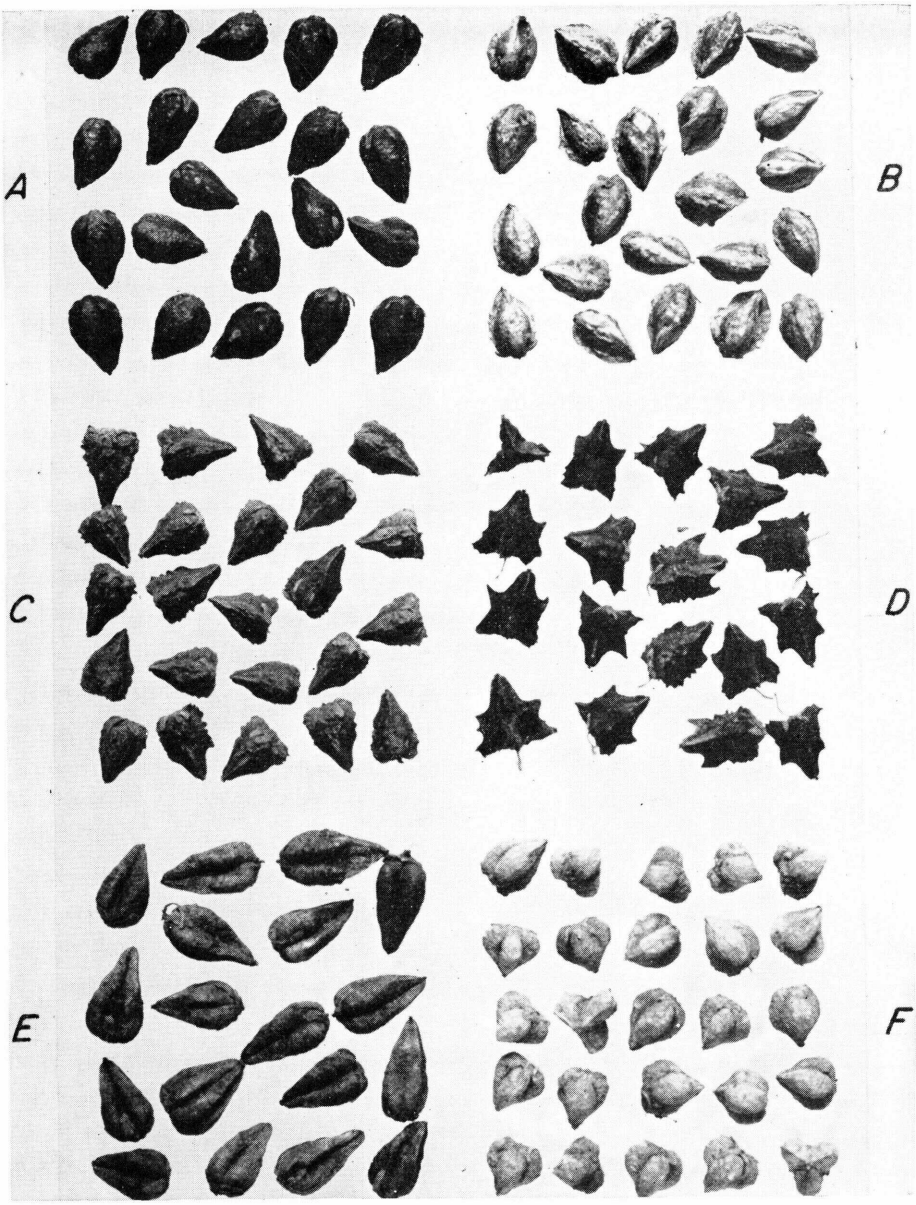

FIGURE 7.—Variants of Tartary buckwheat seed: *A*, With light-spotted hull; *B*, with semidehiscent hull; *C*, sharp pointed with rough hull; *D*, black, dentate, spiny winged; *E*, four-angled Tetratataricum; *F*, top shaped (turbinate) with rough hull. (X2)

ROTATION

Buckwheat is not usually included in a regular rotation because other crops are more profitable on the better lands. On poor lands it leaves the soil too impoverished for succeeding crops. It does this by extracting important mineral elements, especially phosphorus, from the soil. Consequently, buckwheat is sometimes grown year after year on the same land.

Rye is better suited than any other cereal to the poorer soils on which buckwheat is grown. It is probably the best crop to follow buckwheat. A good 4-year rotation is alsike or red clover, buckwheat, corn or potatoes, and rye, oats, or wheat seeded to clover.

Buckwheat is ideal as a catch crop because of its relatively short growing season. Sufficient time is still available for a crop of buckwheat after spring crops like wheat, oats, or corn have failed to make a stand or when unfavorable climatic conditions have delayed early planting of other crops.

Tartary buckwheat may become a weed if it is grown in rotation with small grains. A wheat crop must be used for feed if it contains appreciable quantities of Tartary buckwheat, because the seeds cannot be separated from the wheat.

FERTILIZERS

Fertilizers improve the yields when buckwheat is grown on poor soils. In most soils the application of phosphorus is likely to give the most consistent increase in yields of buckwheat. Experiments at the New Jersey Agricultural Experiment Station indicate that buckwheat utilizes phosphorus of the less soluble rock phosphates almost as readily as it does phosphorus from the more readily soluble superphosphate. Either rock phosphate or superphosphate may be applied with satisfactory results. Sufficient phosphorus for a maximum crop is contained in 200 to 300 pounds of superphosphate.

Potassium, which is used by buckwheat in comparatively large quantities, is probably present in sufficient amount in most soils to produce a good crop. In some soils, potash applied with lime and phosphorus may increase the yields.

A little nitrogen in the soil is indispensable. However, excess nitrogen is likely to increase the size of the buckwheat plants and reduce the yield of grain.

There are three ways in which to supply the nitrogen necessary for growing a good crop of buckwheat on soils low in organic matter:

1. Growing other crops, such as clovers or other legumes, in a rotation schedule. This method will also improve the physical condition of the soil.
2. Adding lime to increase the rate of decay of the organic matter in soils deficient in nitrogen. Increased yields of buckwheat result from the application of 500 to 1,000 pounds of lime per acre.
3. Applying 100 to 300 pounds of a complete fertilizer low in nitrogen, such as a 3–12–6 or a 3–12–12 formula. Manure is not considered advantageous to the buckwheat crop.

When buckwheat is grown for the production of rutin, the use of fertile land is desirable. On land that has not been fertilized recently, the application of a complete fertilizer such as a 5–10–5 at the rate of 200 or 300 pounds to the acre will increase the rutin yield.

VARIETIES

The varieties of buckwheat commonly grown in the United States are Japanese, Silverhull, and Common Gray, which belong to the species *F. esculentum,* and a wing-seeded form of the Japanese variety, which is sometimes considered a different species, *F. emarginatum.* All these varieties are known as common buckwheat.

Tartary buckwheat, another variety,

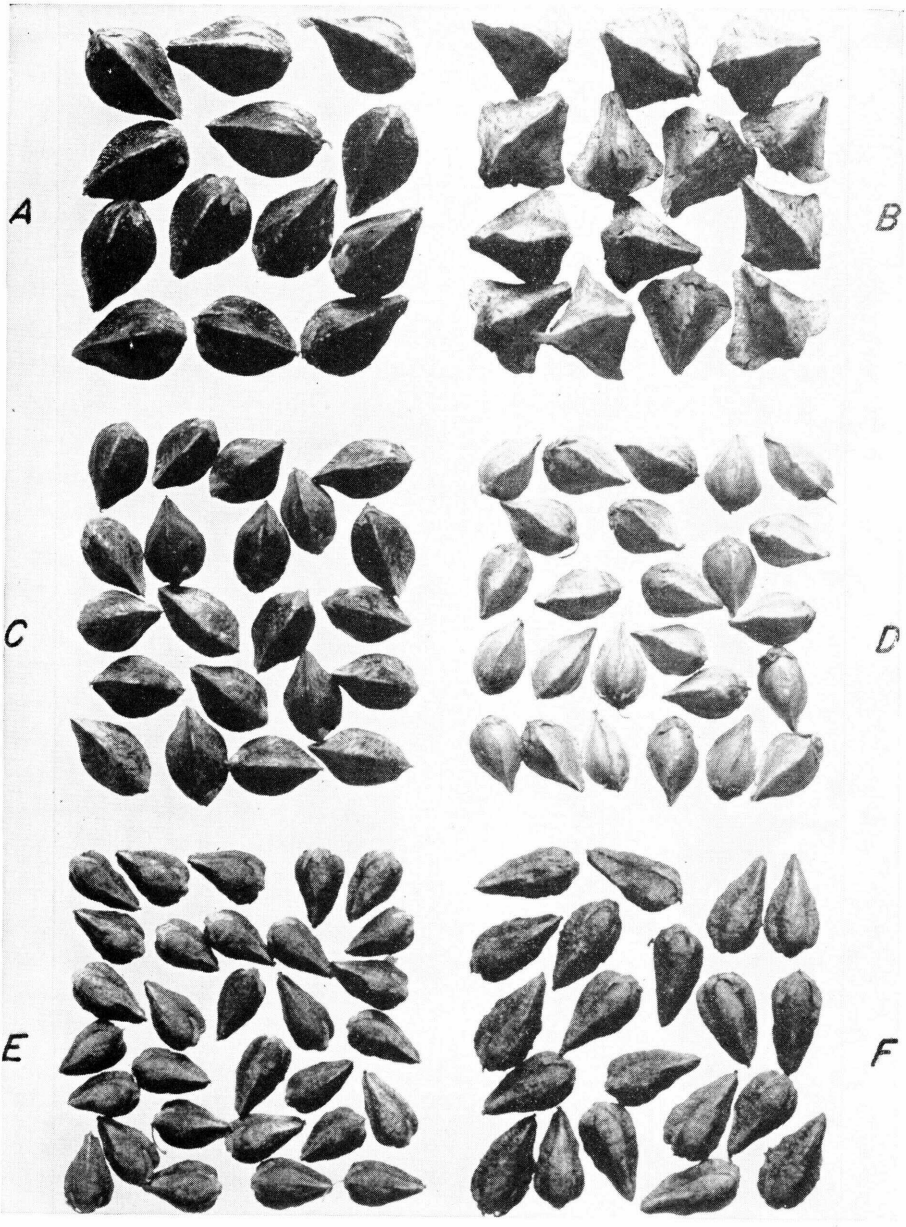

FIGURE 8.—Seed of six buckwheat varieties: *A*, Japanese; *B*, Japanese winged (*Emarginatum*); *C*, Common or Common Gray; *D*, Silverhull; *E*, Tartary; *F*, Tetratataricum. (X2)

belongs to the species *F. tataricum*. It is important because it produces high yields of rutin. Also high in rutin content is an interesting new type, known as Tetratataricum, which is not grown commercially.

Several named varieties of buckwheat have been introduced into the United States from foreign countries. These include Russian #1, Orenburg #6, and Sando Soba.

The Japanese variety is probably grown most widely. Its seed is large, smooth, and brown to almost black (fig. 8, *A*). In cross section the seed is nearly triangular. The plants are 1 to 6 feet high, and average 3 feet under favorable conditions. The stalks are stout and strong. Their thick branches are rather widely separated on the main stem; they bear leaves that are usually large and heart shaped. The sepals are white and the flowers, when in full bloom, have a diameter of about one-fourth of an inch.

The wing-seeded form (*Emarginatum*) is occasionally found as an admixture in the Japanese variety (fig. 8, *B*). The seed differs from that of the Japanese in that the angles of the hulls are extended to form wings. The plants mature later and lodge less readily; they have a higher rutin content than the Japanese or Silverhull variety. The wing-seeded form crosses readily with these two varieties and has been difficult to maintain as a pure variety. Plants from winged seeds, grown in a greenhouse, produce seeds with abnormally large wings (fig. 6, *A*); when these large-winged seeds are sown outdoors the plants produce normal-sized seeds (fig. 6, *B*).

The Silverhull variety is distinguished from Japanese by its smaller seed and glossy, silver-gray (fig. 8, *D*), sometimes mottled (fig. 6, *C*) hull. The angles on the seed are less sharp than those of the Japanese variety; thus, the seeds are more nearly round than triangular in cross section. Intercrossing of Silverhull with the wing-seeded form produces a winged Silverhull (fig. 6, *D*). The stems are neither as thick nor as strong as those of Japanese; the leaves are smaller. Silverhull plants branch more freely than do those of the Japanese variety. As the plants approach maturity, the purplish-red pigment on the stems, petioles, and leaves of Silverhull becomes more intensified than on either the Japanese or the Common Gray variety. The flowers are slightly smaller than those of the Japanese, and the sepals may vary from white to pink or red. At maturity the plants are usually several inches taller than the Japanese variety.

The seed of the Common Gray variety (fig. 8, *C*) is intermediate in size between Silverhull and Japanese. This probably is the result of hybridization between the latter two varieties. Its characteristics are similar, however, to those of Silverhull.

An interesting type of *F. esculentum* has long, sharp-pointed, purplish-brown seeds (fig. 6, *F*). The plants are recumbent in their early stages of growth. The leaf is heart shaped with a narrow-pointed apex. The petioles, veins, and margins of the leaf are purple pigmented.

Tartary buckwheat has become prominent because it produces high yields of rutin. Other names for this variety are India wheat, Rye buckwheat, Duck wheat, Bloomless, Hulless, Marino, Mountain, Siberian, Wild Goose, and Calcutta. Tartary buckwheat is not known to intercross with the varieties of common buckwheat. Seeds of Tartary are much smaller than those of the common varieties of buckwheat grown commercially and are nearly round in cross section. Some are top shaped (turbinate), while others are elongate or tooth shaped. The hull varies from dull gray to brown or black, and from smooth to rough or spiny. The seed commonly known as Tartary is shown in fig. 8, *E*. It is elongate, tooth shaped, dull gray to brown or black, with a smooth hull.

The leaves are narrow and arrow shaped. The plants are inclined to

approach a vine condition and have an indeterminate habit of growth. The flowers are very small, about one-half the diameter of the Japanese variety. They have inconspicuous, light-green sepals that make them readily distinguishable from the large, white- or red-flowered varieties of buckwheat. The flowers rarely attract insects. Tartary buckwheat plants are less susceptible to lodging, and their stems are stouter and less fragile, than those of the Japanese, Silverhull, or Common Gray Varieties. The dry-root weight of the Tartary is greater, and the joint sections (internodes) are shorter, than those of the common varieties.

Tartary buckwheat is grown in the mountains of North Carolina, in Maine, and in some sections of New York, Pennsylvania, and Maryland. In these sections Tartary buckwheat is preferred because it is less subject to injury from frost and is a little better adapted to rough, poor land than the other varieties. It seems to be able to set seed better than Japanese and Silverhull. This is probably due to its self-fertility, which permits the flowers to set seed when unfavorably high temperatures prevail. The flour produced from Tartary buckwheat is inferior to that of the common varieties. It has a characteristic bitter taste that makes it undesirable as human food.

Several variants of the species *F. tataricum* are known. One variant is elongate with a light-spotted hull (fig. 7, *A*). Another is small and top-shaped with a smooth, dull-gray hull (fig. 6, *E*). Another is pointed with a rough, brown to black hull (fig. 7, *C*). Still another has a short and pointed black seed; its prominent dentate wings give it a spiny appearance (fig. 7, *D*). An unusual form with a semidehiscent hull has a seed with three rough, prominent lateral ridges (fig. 7, *B*). A narrow, smooth, thin-structured section of the hull between these ridges has a tendency to fracture at maturity and expose the kernels.

Tetratataricum (fig. 8, *F*) is a new type of buckwheat, a doubled or tetraploid form with 32 chromosomes (double the ordinary number), produced by treating the Tartary variety with colchicine, a chemical. Although it is not yet in commercial production, preliminary experiments have shown that it is superior to other buckwheats in rutin content. The plants of Tetratataricum may be either taller or shorter than the Tartary, Japanese, and Silverhull, depending upon the environment. This variety usually grows very slowly during the first month but more rapidly thereafter. Tetratataricum matures about a week later than Tartary. The main stems of the plants may be as much as one-third thicker than those of Tartary. The joint sections (internodes) on the stems are shorter, and the dark-green leaves are more irregular and thicker than those of the other varieties. The leaves, flowers, pollen grains, and seeds are one-third to two-thirds larger than those of Tartary. In general, Tetratataricum produces fewer seeds than Tartary. Tetratataricum does not cross with any other buckwheat except possibly Tartary.

The approximate number of seeds per pound is Japanese 15,000, Common Gray 18,000, Silverhull 20,000, Tartary 26,000, and Tetratataricum 22,000.

SEED AND SEEDING

SEED PREPARATION AND GERMINATION

Buckwheat for seeding should be cleaned to remove broken, immature, or unfilled seeds. Foreign material such as broken stems and weed seeds should be removed also. Uniform, large seeds produce an even stand and vigorous plants.

Buckwheat will germinate at any temperature between 45° and 105° F. Freshly harvested Tartary seed may not germinate until after 30 to 60 days of drying and storage.

Buckwheat seed usually retains its viability for several years, but seed not

more than 1 year old is best to use. Older seed may be used if the rate of seeding is increased to make up for the reduced germination. Old seed produces weak plants that may be slow in becoming established; therefore it should be tested for germination before sowing.

Buckwheat plants will emerge from the soil 3 to 5 days after the seed is planted. The time required depends on the depth at which the seed is planted and the temperature and moisture content of the soil.

DATE OF SEEDING

Buckwheat may be sown at any time after all danger of killing frost is past. Late in the season it must be sown early enough to allow the grain to mature before frost. In any locality buckwheat should be sown at least 12 weeks before a killing fall frost is expected. When sown in the summer the crop is likely to escape hot weather, which causes the flowers to blast and fail to set seed.

Seeding is general in New York, Pennsylvania, and Michigan from about June 25 to July 1. An earlier date is safer for the more northern points in Wisconsin and New York. In Minnesota where the growing season is short and the summers relatively cool, buckwheat is seeded early enough to bring the crop into bloom late in July.

In a few areas buckwheat may be seeded in the spring to allow the seed to set before hot weather arrives. Buckwheat seeded in a mixture with oats or barley is sown in the early spring. It is seldom advisable to seed later than July 15.

Two crops of buckwheat have been raised on the same land in a single season in West Virginia. Although this practice is not recommended, it is possible where the growing season is of sufficient length. In such cases the second crop must be sown immediately after the first one is harvested.

METHOD OF SEEDING

Sowing buckwheat with a grain drill requires less seed and produces more uniform stands. Broadcasting, and covering the seed by using a weeder or light harrow, is a common practice on rough, stony land, or on small fields. This method is also used when seeding equipment is lacking. It is usually satisfactory to seed 1 to 2 inches deep, but shallower seeding is desirable when the soil is loose and moist. Seeding more than 2 inches deep should be avoided.

RATE OF SEEDING

Japanese, Silverhull, and Common Gray buckwheat should be seeded at the rate of 3 or 4 pecks per acre. Two pecks of seed of good vitality is sufficient when sown with a drill in fertile soil free from weeds, but a higher rate should be used if the seed is broadcast. When sown as a companion crop with peas for hay, a seeding rate of 2 pecks or less per acre should be satisfactory. Since the seeds of the Tartary and Tetratataricum varieties are smaller, a rate of 2 pecks per acre is sufficient.

Thin stands of buckwheat produce stout plants that branch freely and resist lodging on good land. When the seeds are sown too thick the plants are spindly, have very short branches, and may fail to produce seed. Maximum rutin production is obtained from seed drilled 1 inch apart in rows 7 inches apart. Buckwheat adapts itself to thin stands by branching about as effectively as do other grain crops that produce tillers.

HARVESTING

Buckwheat is usually harvested when the maximum number of seeds is ripe. Since ripening is rarely uniform, some green seeds are usually present at harvesttime. Sometimes buckwheat is harvested prematurely to avoid frost damage. Some post-

FIGURE 9.—Cutting buckwheat with a grain binder drawn by a tractor.

FIGURE 10.—Buckwheat in long, narrow shocks made by setting up the bundles from a binder in two rows.

harvest ripening continues in the bundle or shock. Considerable loss from shattering may occur if the crop is left standing for a long time; this loss may exceed the increase in yield expected from postponed cutting. Losses may be reduced by cutting in the morning, when the dew is on the plants, or in damp weather.

Buckwheat may be harvested with a combine, binder, self-rake reaper, cradle, or scythe. The equipment to use depends on the purpose for which the crop is grown and the size and nature of the field.

The combine is used where the fields are smooth, level, and large enough to justify its use. Harvesting with a combine should be delayed until nearly all the plants are mature. If immature plants are harvested, the threshed grain will contain green seed and moist fragments of the plants. For safe storage, such grain should be spread on a floor to dry, or passed through an artificial drier.

The grain binder (fig. 9) may be used where the land is not too rough and the buckwheat is tall enough and standing well. Many fields may lodge so badly that harvesting with a binder is difficult unless the cutting is done in only one direction. The binder should be set to tie small bundles, which dry more thoroughly than large bundles. The bundles from the binder should be set in shocks 2 bundles wide and 3 or more bundles long (fig. 10). Better shocks can be made and less loss from shattering occurs if buckwheat is shocked immediately after cutting, before the plants wilt. Binder harvesting causes some shattering of the grain, but this loss is probably no greater than that which occurs when the crop is cut and dropped in loose bunches on the ground.

A cradle is often used for harvesting (fig. 11) small and very rough or rolling fields. The self-rake reaper (fig. 12) is satisfactory on larger and more level fields. Both of these devices drop the crop in loose bunches, which are gathered (fig. 13) and set together to form a loose shock (fig. 14). The shocks may be built by setting the stalks nearly upright and then tying the top of the shock with strands of straw or binder twine.

Buckwheat that is not harvested with a combine is ordinarily left in the shock to dry about 2 weeks before threshing. Sometimes the dried crop is stored in a barn before threshing.

THRESHING

Buckwheat threshes more easily than most grains or cereals. A smooth concave in the thresher separates the seed adequately and prevents excessive cracking of the grain and breaking of the stems. Some buckwheat is threshed with a hand flail.

YIELD

Buckwheat yields usually range from 10 to 50 bushels to the acre; yields of 25 to 30 bushels are common under good conditions. Under very favorable growing conditions yields may be 80 or more bushels to the acre on small fields. The average yield of buckwheat in the United States in 1952 was 19.6 bushels per acre. When sown at the normal seeding rate, Tartary buckwheat has produced, on the average, a 15-percent greater yield in grain than Common Gray, Silverhull, or Japanese.

The weight of straw is usually slightly larger than the weight of the seed.

The legal weight of a bushel of buckwheat is 48 pounds.

DISEASES AND ENEMIES

Serious losses of buckwheat do not occur often from plant diseases and enemies. A leaf spot [2] has been re-

[2] *Ramularia* sp.

FIGURE 11.—Harvesting buckwheat with a cradle.

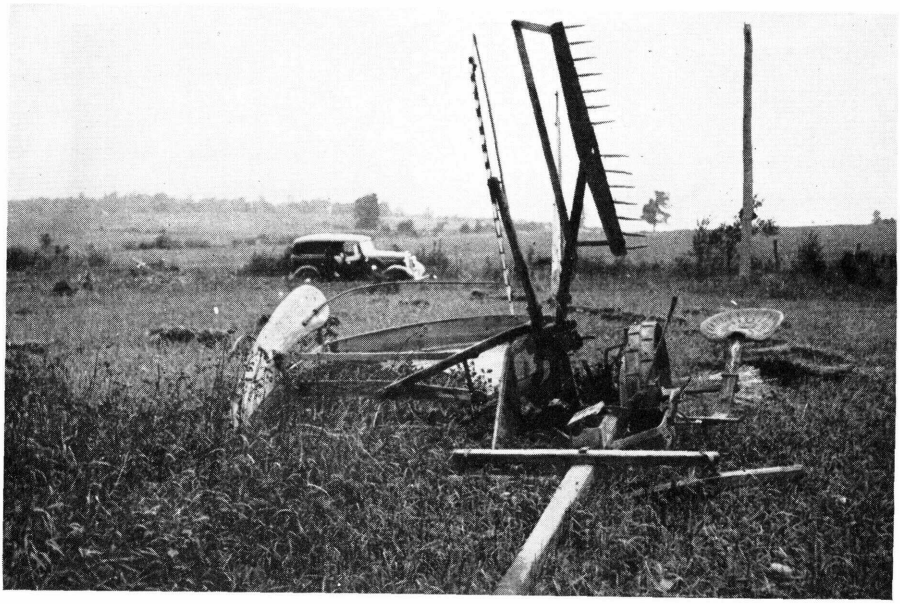

FIGURE 12.—Self-rake reaper sometimes used to harvest buckwheat.

FIGURE 13.—Bunching, preparatory to shocking buckwheat cut with a cradle.

FIGURE 14.—Buckwheat in shocks made by tying unbound bunches with strands of plants or binder twine.

ported in certain sections of North Carolina, as has also damage from root rot.[3] Neither of these diseases has been reported as doing serious damage in the important buckwheat areas. The blasting of flowers is not due to disease but to unfavorable weather conditions.

Wireworms have been reported as damaging to seed and roots of buckwheat in North Carolina. Aphids sometimes attack the plants and undoubtedly do some damage. Buckwheat is not injured by chinch bugs, and in Illinois it has been recommended as a crop on which these insects do not feed. Considerable damage may result from attacks on the buckwheat plants by the Japanese beetle.[4] These insects are particularly fond of the flowers.

Birds and poultry, when numerous, consume a considerable quantity of the grain before it can be threshed. Rats and mice can be very destructive in buckwheat fields; they eat large quantities of the seed, especially from plants that are lodged or left standing in the shock for a long time.

USES OF BUCKWHEAT

About 75 percent of the buckwheat harvested during the past 10 years has been used for feeding livestock and poultry, about 6 percent is used for seed, and the remaining 15 to 18 percent of the crop is milled into buckwheat flour. Between 5 and 10 percent of the seeded acreage is not harvested but is turned under for green manure. Several thousand acres are harvested green for extracting rutin.

Buckwheat grain contains about 10 percent protein, 73 percent carbohydrates, 2.2 percent fat, and 14.8 percent water. It contains a little less protein than wheat, rye, barley, or oats, but slightly more than corn. The carbohydrate content is slightly less than that of wheat, rye, barley, and corn, but more than that of oats. Buckwheat contains more fat than wheat, rye, or barley, but only about one-half as much as oats or corn. The fiber content of the grain is about the same as that of oats, about twice that of barley, and about four times that of wheat, rye, or corn.

FOOD FOR HUMANS

Buckwheat flour has an energy value in calories about equal to that of whole wheat, limburger cheese, or certain cuts of raw ham or beef. The flour is used in buckwheat cakes, which are made from a batter containing buckwheat and wheat flours, water, and yeast or some other leavening agent. Most buckwheat mixes contain buckwheat mixed with wheat, corn, or rice flours and a leavening agent. Buckwheat cakes are generally dark, because fragments of the hull of the grain are present in the flour. Both Silverhull and Japanese are used for making flour. Some millers prefer the Silverhull variety because it has more endosperm and thinner hulls, and consequently yields more flour.

Buckwheat groats are kernels with the hulls removed. Unbroken kernels are sold as whole groats, and those broken in milling are sold as medium and fine groats. The groats may be sold toasted or raw. Groats are used for breakfast food, porridge, and thickening for soups, gravies, and dressing. Japanese buckwheat is preferred for groats because of the shape and large size of the kernels. Some millers consider groats more in demand than buckwheat flour.

Buckwheat flour and groats must be used fresh because their fat content is high and they soon become rancid. This poor keeping quality makes buckwheat products difficult to handle in the summer.

When buckwheat is eaten continually or in large quantities, it sometimes causes a rash on the skin.

[3] *Rhizoctonia.*
[4] *Popillia japonica.*

FEED FOR LIVESTOCK

Buckwheat is a satisfactory partial substitute for other grains in feeding livestock. It has a lower feeding value than wheat, oats, barley, rye, or corn. The grain should be ground and mixed with at least two parts of corn, oats, or barley.

When fed continually or in large amounts to certain animals, buckwheat grain may cause a rash to appear on the skin. This rash is confined to the white-haired parts of the hide of the animal, and apparently occurs only when animals are exposed to light. The substances that produce the rash are in the buckwheat hulls.

Tartary buckwheat has a lower feeding value for livestock than the common varieties, but it is used extensively as an ingredient of scratch feeds for poultry. The small, smooth, rounded seed of Tartary makes it more satisfactory for poultry than the larger and more angular seeds of common buckwheat.

Buckwheat middlings are rich in protein, fat, and minerals, and are considered a good feed for cattle when not fed in large amounts or as the only concentrate. They may also be used satisfactorily as a substitute for linseed meal in a ration consisting of tankage, linseed meal, and alfalfa hay. Buckwheat middlings apparently have no harmful effect on dairy cows or dairy products. They are not satisfactory for pigs when fed as the only concentrate, and are not so palatable to pigs as are other ground grains.

Buckwheat hulls have little or no feeding value, but they are sometimes combined with middlings and sold as buckwheat feed or bran.

Buckwheat straw is sometimes used for feed when well preserved, but may cause digestive disturbances when fed in large amounts.

SOURCE OF RUTIN

Rutin is a flavonol glycoside obtained from dried or green buckwheat plants. It is used to strengthen weak capillary blood vessels and to prevent or reduce certain types of hemorrhage. Rutin is also effective in the treatment of frostbite and burns produced by X–rays, and it may benefit persons exposed to dangerous atomic radiation.

The rutin content of buckwheat plants ranges from 1 to 6 percent. The leaves and flowers are richest in rutin.

Tartary, Tetratataricum, and Japanese winged (*Emarginatum*) have a higher rutin content than do the other varieties of buckwheat. Tetratataricum, which is highest in rutin content, is not yet grown commercially. These three varieties retain their rutin content over a longer growing period than other varieties. Tetratataricum grows more slowly, especially in the first month, than the other varieties. It continues to grow for a much longer time and can be harvested as late as 50 days after emergence. It is often desirable to make progressive plantings to supply material for a continuous drying operation.

For rutin production, best results are obtained by seeding on fertile, well-prepared soil. On fields not recently fertilized, 200 to 300 pounds to the acre of a complete fertilizer, such as 5–10–5, should be applied at seeding time. The best results are obtained when buckwheat is drilled in rows 7 inches apart, at a rate of 2 or 3 pecks per acre. Since the crop for rutin is harvested before seeds set, as many as three crops may be obtained from the same field in areas with a long frost-free growing period. The buckwheat plants are cut during the blossoming period with a forage harvester, 4 to 6 inches above the ground. In general, spring seeding produces plants with a higher rutin content but lower yields per acre of rutin than does summer seeding. The percentage of rutin in the plants decreases considerably after the seeds begin to set.

If the weather is sunny, buckwheat may be mowed and left on the field to dry partly for 2 or 3 hours. If cut at

night, or when the weather is cloudy or humid, it may be taken immediately to the drier. Drying the harvested buckwheat and preparing the leaf meal should be done near or on the producing farm to avoid loss of rutin. A high-temperature, direct-fired, rotary alfalfa drier is satisfactory, but other types of driers may also be used. Descriptions of efficient portable and stationary rotary driers may be obtained from the United States Department of Agriculture.[5]

After being transported from the field to the drying equipment, the plants are first chopped into 1-inch pieces, with an ordinary forage cutter. They are then passed through a heated rotary cylinder and blown by a centrifugal fan into a cyclone separator. The hot gases from the drier are eliminated at the top. The heavier foreign matter, such as dirt and stone, is removed at the bottom of the separator. The cleaned plant fragments are then blown into a second cyclone separator from which they are deposited on a vibrating 5-mesh screen that separates the leaf meal from the stem material.

To produce 1 ton of leaf meal requires the drying of about 10 tons of freshly harvested buckwheat plants. Rutin is extracted from the dried leaf meal with hot water or dilute alcohol. Details of these processes may be obtained from the Eastern Utilization Research Branch, Agricultural Research Service, United States Department of Agriculture, Philadelphia 18, Pa.

SMOTHER CROP

Buckwheat germinates and shades the ground quickly where the soil is fairly good. On fertile soil it reaches a height of about 1 foot within a month after seeding. This rapid growth soon smothers most weeds. Buckwheat is useful in fighting quackgrass, a pest on many farms in the Northeastern States. Some farmers report that buckwheat completely eradicated quackgrass in a single season, but such rapid control is not usually to be expected. The land should be cropped a year to corn or other cultivated crops to get rid of the quackgrass sod, and then plowed in the fall or early spring and harrowed occasionally until buckwheat-sowing time. Some fertilizer should be added if the land is poor. Four or five pecks of buckwheat seed to the acre should be sown to obtain a thick stand. A heavy growth of buckwheat should smother most of the quackgrass, and still produce a good crop of grain.

SOIL RENOVATOR

Buckwheat is valuable as a soil renovator, particularly on land too poor to grow other crops successfully. The green succulent plants decay quickly when plowed under and replenish certain mineral constituents of the soil. The Pennsylvania Agricultural Experiment Station reports that 2 tons of green buckwheat in full bloom can return plant food equivalent to that contained in 125 pounds of sulfate of ammonia, 62 pounds of 16-percent superphosphate, and 80 pounds of 50-percent muriate of potash. The humus supplied by buckwheat plants when plowed under improves the physical condition and moisture-holding capacity of the soil. The roots of the plants loosen hard soils so readily that erosion may occur when the crop is removed. Under such circumstances, a winter cover crop should follow buckwheat.

Very poor land can be built up by sowing rye with buckwheat. The two grains are sown at the regular time for sowing buckwheat; buckwheat is planted at the rate of 1 or 2 pecks to the acre and rye at 4 to 5 pecks to the acre. The rye is shaded and held in check by the more rapidly growing

[5] Phillips, G. W. M., Aceto, N., Eskew, R. K., and Hurley, R. PRODUCTION OF BUCKWHEAT LEAF MEAL IN ROTARY ALFALFA DRIERS. U. S. Bur. Agr. Indus. Chem. AIC–264, [11] pp. 1950. [Processed.]

buckwheat until the latter is harvested. The rye is left to develop and occupy the land over the winter. It is plowed under as a green manure in the spring. This procedure can be repeated each year until the land is improved sufficiently to grow other crops. The most feasible practice may be to drill rye in the buckwheat stubble. This is often possible without previous disking or plowing.

Buckwheat is used frequently as a summer cover crop in orchards and vineyards. The advantages of a legume in the cover crop are gained by adding field peas. Buckwheat mixed with Canadian field peas makes a satisfactory summer cover crop in New York. An objection to this combination is the rank growth (average 2½ feet in the latter part of September) that interferes with the gathering of fruit, especially on wet days. This may be prevented by rolling down the buckwheat plants before fruit picking. The carpet of vegetation thus obtained helps prevent injury to falling fruit.

HONEY PLANT

Common buckwheat varieties are important sources of honey. Growing buckwheat helps increase farm income in many areas, but is not usually economical solely for honey production. Bees extract the nectar from glands located at the base of the numerous small white flowers, which bloom for a month or more. A field of buckwheat at blooming time presents a mass of flowers, as shown in fig. 15. No honey is obtained from the Tartary or Tetratataricum varieties.

An acre of buckwheat may supply as much as 150 pounds of honey in a season. The honey is dark and has a strong flavor that is unpleasant to some persons. It is highly regarded, however, in sections where it is produced.

Commercial beekeeping in buckwheat-growing sections provides the necessary cross-pollination for grain production.

MILLING[6]

A few mills still use old-fashioned stone burs to produce buckwheat flour, but the greater number use steel rolls. The milling process may be described briefly as follows: The grain is cleaned thoroughly to remove dirt and foreign material and then dried to approximately 12-percent moisture. It is then scoured to remove dirt, fuzz, and calyxes adhering to the fruit. The scoured seed is passed through the first break rolls, which crack and loosen the hulls. During this process some moisture may be absorbed. Redrying to 12 percent is necessary to facilitate the separation of the meal from the hulls. The material then goes to sieves, which remove the hulls and separate the flour and middlings. The broken material left is reduced by one or more sets of rolls; each grinding operation is followed by a sifting that removes the flour from the middlings. Some buckwheat flour is milled so fine and is so refined that it is as white as wheat flour. Usually, however, coarser bolting cloths are used, through which small particles of hull pass. These particles remain in the flour and give it a characteristic dark color.

One hundred pounds of clean, dry buckwheat yields 60 to 75 pounds of flour, 4 to 18 pounds of middlings, and 18 to 26 pounds of hulls. Not more than 52 pounds of pure white flour from 100 pounds of grain is obtained in milling. Buckwheat more than 1 year old is reported to make flour inferior to that made from freshly harvested grain.

The middlings, composed mostly of the germ and the inner covering of the grain just beneath the hull, are used for feed.

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[6] A complete discussion on milling and chemical composition of buckwheat is contained in U. S. Dept. Agr. Cir. 190, BUCKWHEAT MILLING AND ITS BYPRODUCTS. 12 pp., illus. 1931. (Out of print.)

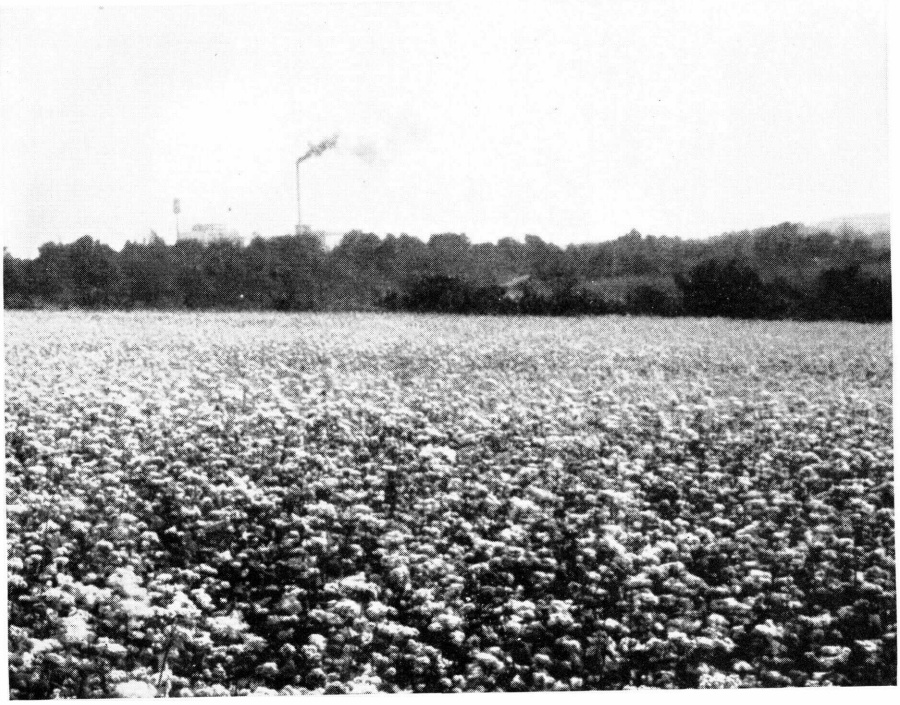

FIGURE 15.—Field of Japanese buckwheat in bloom.

The hulls are used for fuel, as packing for bottled goods, chinaware, glass and bulbs, as insulating material, and as a soil mulch or compost. When used for bedding, the hulls apparently irritate the feet of livestock.

In milling for groats, the grain must be graded carefully for uniform size. The cleaned and graded grain is passed between two millstones adjusted to crack the hull without breaking the groats appreciably. The hulls are removed by sifting the product and all dust is taken out by aspirator purifiers. The product is then graded into whole groats and two or more sizes of broken groats.

Tartary buckwheat is not satisfactory for milling because the flour has a dark color and a bitter taste. Many millers consider this variety so objectionable that they reject for milling purposes any buckwheat contaminated by seeds of Tartary.

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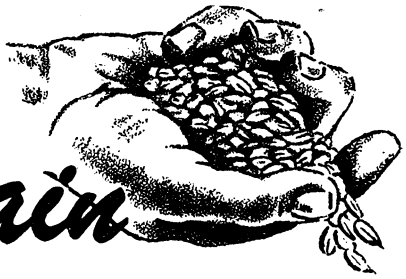
Clean Grain



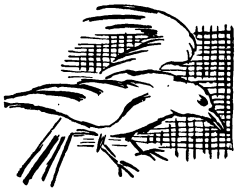
Makes wholesome flour and cereal products

Cleanliness in grain begins on the farm

Insects, birds, and rats and other rodents that get into stored grain cause enormous losses. They waste the nation's food and eat away your profits. You can help cut these losses by making sure that all the grain you store and handle is clean.

Keep rats and mice out with better storage construction. Poison and trap rodents and clean up places where they may hide and live.

Keep insects out. Fumigate old stored grain. Before storing new grain, get rid of insects by cleaning the bins and areas surrounding them. Spray bins with insecticide.



Use screens to keep out birds and poultry. Use ½-inch mesh hardware cloth or similar material over all windows and other openings.

GRAIN IS FOOD • • • KEEP IT CLEAN